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ABSTRACT

Agriculture generates byproducts that may contribute to the contamination of the United States' water supply. Any effective regulations to ban or restrict agricultural chemical or land use practices in order to improve water quality will affect the farm economy. Some farmers will benefit; some will not. Most agricultural pollutants reach surface waterways in runoff; some leach through soil into ground water. Because surface water systems and ground water systems are interrelated, farm management practices need to focus on water quality in both systems. Modifying farm management practices may raise production costs in some areas. Farmers can reduce runoff losses by reducing input use, implementing soil conservation practices, and changing land use. Also at issue is who should pay for improving water quality: farmers, governments, consumers, or those who benefit from improved water quality. (Author/KC)

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Agriculture and Water Quality

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Agriculture generates byproducts that may contribute to the contamination of our Nation's water supply. Any effective regulations to ban or restrict agricultural chemical or land use practices in order to improve water quality will affect the farm economy. Some farmers will benefit; some will not. Most agricultural pollutants reach surface waterways in runoff; some leach through soil into ground water. Because surface water systems and ground water systems are interrelated, farm management practices need to focus on water quality in both systems. Modifying farm management practices may raise production costs in some areas. Farmers can reduce runoff losses by reducing input use, implementing soil conservation practices, and changing land use. Also at issue is who should pay for improving water quality: farmers, governments, consumers, or those who benefit from improved water quality.

Loss of sediment and agricultural chemicals into the environment is a natural part of agricultural production; low concentration levels of these substances are probably harmless. But, concern is growing about the effects of higher concentrations. Public concerns about the damage to water quality by pollution that has no single, easily identifiable source (nonpoint-source pollution, particularly from agriculture) have led in the last decade to legislated regulations and programs to protect surface water (streams, rivers, and lakes) and ground water (underground water that supplies wells and streams). Local effects of these regulations and programs will depend on a farmer's location, type of farm, and current management practices. These regulations will likely change how agricultural resources are allocated, increase taxpayers' costs for water quality protection, and alter prices of some farm products.

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Agricultural Residuals

Agricultural nonpoint-source pollution can reach waterways through runoff from cropland, pastureland, barnyards, and feedlots. Ground water can be polluted by soluble substances leaching through the soil. Potential pollutants include sediment, nutrients, pesticides, nitrates, bacteria, and dissolved solids such as calcium, magnesium, and other salts.

Runoff from rain and melting snow can detach sediment from farmland and move it into streams and rivers where it clouds the water and silts up lake beds and river channels. Nutrients from commercial fertilizers, animal manure, legume crops, and crop residues can reach waterways attached to sediment or dissolved in runoff. These nutrients promote rapid growth of algae and other plant life which clog waterways and reduce the dissolved oxygen in the water available for fish and other marine animals.

Pesticides and nitrates applied to cropland can reach waterways in runoff and reach ground water by leaching through the soil. Bacteria from animal manures move into waterways in runoff. Salts leached through the soil by irrigation water can reach surface water in irrigation return flow.

The contribution of cropland or other nonpoint sources to pollution varies from one location and time to another. Identifying which land and land use is subject to substantial loss of sediment, nutrients, and pesticides is difficult without expensive monitoring systems. The variability of climate, soil traits (erodibility, hydrological features, ability to bond with chemicals, productivity for crop production), a watershed's ability to absorb pollution, and other factors make it difficult to

evaluate how much a single field or farm affects water quality downstream.

Most farmers base their production decisions and levels of input use on costs and returns. These decisions are not necessarily linked to the societal costs of agricultural pollution, which may be much higher than production costs. Thus, regulation is seen by many as a way to forge the link that will protect the environment from the damaging levels of agricultural input use that may result from private decisionmaking.

Agriculture and Surface Water Quality

Sediment and its polluting byproducts may cause an estimated $5-$15 billion of offsite damage (damage that appears somewhere other than the originating farm) to surface water in a given year. Cropland is the likely source of approximately a third of all sediment loads and, hence, damage. Damage includes siltation of navigation waterways, water-storage facilities, municipal and industrial plants, drainage ditches and irrigation canals, and water-based recreation facilities. The costs of damage from dissolved nutrients, pesticides, salts, and bacteria have not been estimated. Such offsite costs are not normally included in farmers' production costs or consumer food prices, but rather are incurred by those who use water containing agricultural byproducts.

Data from a national water-quality monitoring system have documented pollutant concentrations in surface water. Crop production has been associated with higher than normal levels of agricultural pesticides and nutrients in surface waters. Certain regions and areas within regions are associated with higher levels of pollution and/or incur more damage from agricultural nonpoint pollution than others, depending on the characteristics of the land and how it is used. Areas likely to have serious nonpoint pollution problems are also likely to have greater rainfall, steeper topography, more erosive crops, more intensive land use, heavier chemical use, larger affected populations, and more sensitive waterbodies than areas with fewer pollution problems.

All factors affecting water quality and resulting economic damage must be considered before implementing water-pollution control efforts. For example, the Corn Belt generates substantial erosion and sediment because it uses land extensively for farm crops. However, regions with dense populations, high incomes, and concentrated industry such as the Northeast and the Lake States will feel the effects of water pollution more than a region like the Corn Belt that may have greater erosion problems but fewer people to feel its effects. But, offsite damage associated with water pollution cannot be measured directly and the links between farming and affected water uses are not well defined. Many assumptions are made to estimate offsite damage, and both methods and data for estimating damage need to be improved.

Many soil conservation programs, addressing soil erosion problems, also control sediment and associated water pollutants. Examples of such practices include conservation tillage, terrace and diversion systems, sod waterways, and cover crops. Careful management of pesticide, nutrient, and animal waste use, in conjunction with soil conservation practices, will usually reduce farm pollutants in surface waters to reasonable levels.

Agriculture and Ground Water Quality

Over 97 percent of rural Americans and nearly half of the total population rely on ground water for drinking and household uses. The potential for contaminating ground water supplies is increasing as farm production is concentrated on less acreage and as the reliance on chemicals to produce more food with less land and labor increases. Our reliance on ground water and the difficulty of cleanup once contamination occurs suggest a need to protect existing water quality, especially since pollutants in ground water can move into surface water.

Agricultural nitrates and pesticides can leach into ground water as a result of increased use of nitrogen fertilizers and pesticides, conservation practices which reduce runoff and increase water infiltration into the soil, and irrigation.

Ground water contamination occurs only in certain places, making it difficult to draw a broad perspective on pollution issues. Sites cannot be compared because data for individual wells are inconsistent. Evaluating the full extent of ground water pollution is made even more difficult by variations in well depths, sampling periods, chemicals tested for, land uses above contaminated sites, soils, and biologic, hydrologic, and geologic characteristics.

Some studies have correlated land use with ground water contamination for specific sites. These studies, however, have not produced results that could apply to a more general area. Because of the expense, monitoring programs have tested only a small number of the potentially contaminated wells. Still, thousands of wells are contaminated with agricultural pesticides and/or nitrate concentrations exceeding EPA (Environmental Protection Agency) guidelines.

Most contamination resulting from normal agricultural chemical use has not caused serious alarm, based on what we currently know about the health effects of low levels of nitrates and pesticide residues. However, there are risks of long-term increases in concentrations if pesticide and nitrogen use continue at present rates. The potential health risks associated with pesticides and other pollutants in ground water and the involuntary exposure of people to these compounds have forced government officials at all levels to address liability questions. But, since identifying which farms are the source of chemicals found in ground water is difficult, if not impossible, uncertainty in assigning liability for ground water contamination complicates efforts to control or reduce the effects of agricultural applications of chemicals.

Comprehensive data on pesticide levels in ground water do not exist. Nitrate monitoring responsibilities are split among Federal, State, and local water-quality and health agencies, with little data coordination among them. EPA is conducting a national survey of pesticides in drinking water from ground water sources, with results expected in 2 years. More than 40 agricultural pesticides, which in high enough concentrations can pose significant human health threats and are known to leach into ground water, are being investigated. EPA's results will help determine whether a ban or other restrictions will be imposed on the use of any pesticides, depending on the levels of human exposure and the potency of pesticides.

Legislation for Controlling Agricultural Pollution

Water-quality protection may alter where and how crops will be grown, and will certainly influence production practices.

The Water Quality Act of 1987 provides stronger incentives for protecting water quality than any previous national legislation addressing agricultural-source pollution. Each State is required to appropriate funds for addressing nonpoint pollution problems. The legislation also calls for ground water-quality research, assessment, and enforcement. In addition to assessing the extent of nonpoint pollution, States must correct problems by implementing management practices that control agricultural runoff. States can do this by implementing regulatory or nonregulatory programs, or combinations of the two. States are to provide technical assistance, education, training, demonstration projects, and information about the latest technology to farmers.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) empowers the EPA to curb the use of a pesticide if it is harming people or the environment. If EPA finds that a pesticide poses undue risk to human health, or is an imminent hazard in the environment because of its persistence or toxic effects, the EPA may temporarily suspend or permanently ban a chemical's use. More attention has generally been given to leachers (pesticides that are known to leach into ground water) than to chemicals which primarily run off cropland. This attention to leachers is due to the long-term effects they may have on ground water supplies, even though concentrations in ground water seldom exceed seasonal concentrations in agricultural runoff.

The nematocide DBCP, a suspected carcinogen, was banned for agricultural use after it was found in wells in California and other States, even though farmers had not exceeded recommended application rates. Other pesticides have been restricted in use or banned locally because they leach into aquifers and pose potential health risks.

The Safe Drinking Water Act protects potable waters from nonpoint sources of pollution. States are encouraged to develop plans to prevent chemicals and bacteria from contaminating the ground water sources of public wells. A goal of the legislation is to expand control over previously uncontrolled sources of contamination, such as agricultural chemicals and animal wastes. Kansas, for example, passed legislation (Chemigation Safety Act) to minimize ground water contamination coming from agricultural chemicals applied through center-pivot irrigation systems. Other States also have passed legislation to tax chemical use and have used other revenue instruments to provide funds for demonstration and education programs, research, and remedial actions.

Potential Effects of New Regulations

Laws aimed at protecting water quality will affect farmers' pocketbooks. Farmers in critical or sensitive watershed areas could be faced with such actions as:

- o Taxes on nitrogen fertilizer and pesticides.
- o Mandatory soil conservation management practices, with or without Government cost sharing.
- o Bans on certain pesticides known to leach into ground water in significant quantities or known carcinogens.

- o Regulations on land uses, on types of land on which chemicals can be applied, and on the quantity of chemicals used.

- o Mandatory management practices for applying chemicals (for example, requiring injection instead of mixing chemicals with irrigation water).

Any of these actions could change farmers' operations. They could have to:

- o Reduce inputs, particularly nutrients and pesticides.

- o Use structural practices such as grassed waterways to reduce runoff and associated pollutants.

- o Change tillage or other management practices.

- o Change land use, such as altering the intensity of the crop rotation or converting land from row crops to hay.

Any of these changes could cut incomes if production costs increase, yields decline, or both. If fertilizers and pesticides are taxed, farmers will face higher production costs. Constrained fertilizer use will reduce crop yields. If specific pesticides are banned, farmers will have to shift to either more expensive or less effective chemicals, or cultivate more land.

Curtailing nitrogen use or banning heavily used pesticides could mean yield losses for most major crops. Pesticide suppliers could be hurt sharply by widespread bans on some chemicals. And, farm income and corporate profit losses could be substantial. However, some farm income losses could be offset by adopting managment practices such as integrated pest management (closely monitoring crop pests to ensure timely and fewer applications of chemical and biological controls) and changes in crop rotations.

Restrictions on farming could affect local economies and the distribution of cropping activities. For example, some regions would face considerably greater yield losses than others if wide-ranging pesticide, fertilizer, or sediment restrictions are imposed. Regions affected less by environmental controls would acquire a competitive advantage over more affected regions, and production of crops that are affected by bans would shift to less affected regions. Sensitive watersheds targeted for control would become less competitive as production costs rise for affected crops.

Widespread changes in agricultural production, brought about by legislation to protect water quality, could affect crop prices. For example, banning important pesticides such as the triazine herbicides could significantly reduce corn yields and increase corn prices. Farmers would benefit from the higher prices, but consumer costs for food would rise from current levels. However, most steps taken to protect water quality likely will be local, not national, in scope. Therefore, any price changes resulting from water protection regulations will likely be minimal, especially if many crops are in surplus.

Individual farmers and local economies will bear the costs of meeting water quality goals unless the public sector absorbs a portion of the costs and transfers part of the burden to taxpayers. Governments have traditionally shared the cost of soil and water conservation practices. Federal programs that provide cost sharing include the Conservation Reserve Program (CRP), and the Agricultural Stabilization and Conservation Service's Agricultural Conservation Program (ACP) and Rural Clean Waters Program (RCWP). Many States have similar programs. Such programs address not only erosion and sediment problems, but also control nutrients and pesticides in agricultural runoff.

Role of Soil Conservation Programs

Many Federal programs control soil erosion and, coincidentally, the sediment, nutrients, and pesticides which can wash off the land into streams and lakes. The most notable are the soil conservation programs already mentioned and the conservation compliance provisions of the Food Security Act of 1985. These voluntary programs give farmers an economic reason to keep their land in permanent vegetation or to use management practices that control runoff. The programs provide this incentive by sharing the cost of implementing conservation practices with farmers and by paying farm program benefits to only those farmers conserving soil and water resources.

The Food Security Act of 1985 promotes land retirement through several provisions, such as the Conservation Reserve Program, the conservation easement provision, and the annual set-aside provision (Acreage Reserve Program). Other provisions that conserve soil include:

- o A haying and grazing provision for wheat set-aside acreage.

- o A 50/92 provision (for cotton) and 0/92 (for wheat and feed grains), which allows a farmer to put up to 50 percent of cotton acreage (or 100 percent of wheat and feed grain acreage) into conservation uses and receive 92 percent of the

What Can Farmers Do To Control Pollution?

Farmers have practiced soil conservation for most of this century to control the losses of topsoil and to protect the productivity of land. Recent conservation programs have broadened soil erosion and sediment controls to include chemical use and application methods. Increasing the application efficiency of fertilizer, manure, pesticides, and other sources of nutrients is the most direct and most certain way of reducing the probability of contamination of water supplies by these agricultural inputs.

Sediment control includes traditional soil conservation practices such as conservation tillage, contour and strip cropping, and terracing. Sediment can also be controlled by less erosive crop rotations (including permanent vegetation, which is being implemented through the Federal Conservation Reserve Program), sod waterway systems, diversion systems, and sod filter strips. These practices are classified as either structural practices or management practices. Structural practices generally cost more to implement, and the Government has usually paid a greater cost share for structural practices than for management practices.

Sediment control cannot prevent losses of nutrients and pesticides that are dissolved in runoff or prevent chemicals from leaching into ground water. Careful application of chemicals helps to prevent ground water contamination where the potential for leaching is high. The leaching problem is often exacerbated by increased infiltration of water associated with runoff control.

Currently, 33-50 percent of nitrogen and 10 percent of pesticides applied to cropland ends up in surface runoff or leaches into the soil in regions where nonpoint pollution is a serious problem. Changing management practices so that nutrients and pesticides are applied when the crops need them most will ensure maximum use by plants and will lower the probability that agricultural chemicals will affect water quality. However, a tradeoff exists because reducing pesticide applications requires more cultivation to control weeds and other crop pests, and can result, therefore, in more soil erosion.

Farmers can manage manure runoff from barnyard areas better by building barnyard runoff control structures and manure storage facilities, and by using related practices such as sod filter strips. Manure storage also allows farmers to apply manure nutrients when crop needs are greatest, thus reducing the likelihood of runoff. Farmers can also increase the land area upon which manure is spread to reduce nutrient concentrations, export manure and other nutrients off the farm, or change the crop mix to include more acreage in crops that use lower amounts of nitrogen and phosphorus.

Irrigation applications that exceed crop needs can increase runoff losses, chemical leaching, or both. Applying only enough water to plants to satisfy their growth needs, without exceeding the waterholding capacity of the soil, will limit runoff losses. Application of soluble chemicals on irrigated cropland should be based on soil characteristics, reasonable yield goals, irrigation methods, tillage practices, and chemical application methods. Tailoring chemical management to specific situations is more effective and should be less costly than applying general standards for chemical use to all cropland.

deficiency payments that would have been received if the entire permitted acreage had been devoted to the program crop.

o A sodbuster provision, which requires conservation planning prior to bringing grassland into row crop production.

o A conservation compliance provision, to be implemented by 1995.

Soil conservation efforts should substantially improve water quality. Time will tell whether current soil conservation programs are adequately protecting surface-water quality from agricultural pollutants other than sediment. Soil conservation provisions which retire cropland and reduce or eliminate the use of agricultural chemicals should improve the long-term quality of both surface and ground water.

Who Pays?

Who should pay the cost of cleaner water? Some argue that pollution-generating farmers should pay for reducing pollutants leaving their farmland, just as industrial polluters must bear the costs of installing pollution control equipment. However, farmers alone are unlikely to bear all of the costs of protecting water quality. Those water-users benefiting from improved water quality will likely pay part of the cost, in the form of higher taxes, to subsidize water-quality protection efforts.

Federal and State governments could share the cost of implementing improved management practices, just as they now share the costs of soil conservation programs such as the Agricultural Conservation Program.

The Government funds research into alternative pesticides and pest control strategies in order for farmers to reduce their reliance on pesticides which may be banned for environmental reasons. Consumers will pay higher food prices if farmers' costs of production are significantly raised by efforts to reduce chemical or sediment discharges. The willingness of farmers and the rest of society to bear the costs of reducing agricultural water pollution will determine the quality of our water resources.

For Additional Information...

Contact Marc Ribaudo, (202) 786-1444, Resources and Technology Division, Economic Research Service, U.S. Department of Agriculture, Room 438, 1301 New York Avenue, NW., Washington, DC 20005-4788.

Current Debate on Farm Policy . . .

Is based on conflicting reaction to the Food Security Act of 1985. A decision made on behalf of one group may have unanticipated or adverse effects on others. This bulletin is one in a series published by USDA's Economic Research Service aimed at informing those debating farm policy about the highly interrelated nature of agricultural policymaking. Other reports look at the background to farm policies, including who is affected and how.

Here is a list of the reports that are available. To order these or to learn about upcoming reports, write to ERS Information, Room 208, 1301 New York Avenue NW, Washington, DC 20005-4788.

Choices for Implementing the Conservation Reserve (AIB-507)

Economic Growth, Agricultural Trade, and Development Assistance (AIB-509)

New Approaches to Financing Long-Term Debt (AIB-511)

Paying for Marketwide Services in Fluid Milk Markets (AIB-514)

Increased Role for U.S. Farm Export Programs (AIB-515)

Effects of Monetary and Fiscal Policy on U.S. Agriculture (AIB-517)

Challenges in Designing U.S. Farm Policy (AIB-518)

Mandatory Production Controls (AIB-520)

Redistributing Farm Program Benefits (AIB-522)

The Policy Web Affecting Agriculture: Tradeoffs, Conflicts, and Paradoxes (AIB-524)

Price Parity: An Outdated Farm Policy Tool? (AIB-531)

U.S. Grain Imports by Developing Countries (AIB-542)

Debt Crisis in Developing Countries Hurts U.S. Agriculture (AIB-546)

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